

Not Available under NASA sponsorship
in the interest of early and wide dissemination of Earth Resources Survey
Program information and without liability
for any use made thereof."

E7.3 108.05.
CR-133289

TYPE II PROGRESS REPORT - NUMBER 2

Period: January 1, 1973, to June 30, 1973

INVENTORY OF FOREST AND RANGELAND AND DETECTION OF FOREST STRESS

GSFC Identification Number AG-014, MMC-226
Contract Number S-70251-AG

Report date - July 10, 1973

(E73-10805) INVENTORY OF FOREST AND
RANGELAND AND DETECTION OF FOREST STRESS
Progress Report, 1 Jan. - 30 Jun. 1973
(Pacific Southwest Forest and Range
Experiment) 21 p HC \$3.25 CSCL 20F G3/13 00805
N73-27280
Unclas

Principal Investigator - Robert C. Heller

Forest Service, U. S. Department of Agriculture
Pacific Southwest Forest and Range Experiment Station
P. O. Box 245
Berkeley, California 94701
(415) 841-5121 ext. 540

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

22 PP

TITLE: Inventory of Forest and Rangeland and Detection of Forest Stress

ERTS Proposal Number 226

Black Hills Test Site (Forest Stress) 226A

Coinvestigator: F.P. Weber

GSFC Identification Number AG-014

Principal Investigator: Robert C. Heller

STATEMENT OF PROBLEMS:

1. Our primary problem is the receipt of one good ERTS frame covering our entire Black Hills study site when free of clouds and during the growing season. We have received several good frames during October 1972 and January and February 1973, but have discovered that these frames are snow covered. Unfortunately, the high radiance from snow obscures lower radiance differences between healthy and discolored vegetation. Forest stress differences obviously must be made during the spring, summer, and early fall in the absence of a snow background.

Table 1 is a summary of all the ERTS-1 imagery received of the Black Hills, South Dakota, ERTS test site 226A. The images are listed in the order received from the NASA Data Processing Facility. Columns 4 through 7 were the criteria used to determine the suitability of the imagery for our study purposes. Columns 4, 5, and 6 are under the general heading Test Site Area. If any of our study site was covered on the image, the percent of the area covered was estimated. If the study site was covered, the percent cloud cover over the study site was estimated. If there was a substantial amount of snow covering the study site an X was placed in column 6. Column 7 gives a subjective measure of the image quality ranging from poor to excellent. Note particularly the footnotes (A and B) at the bottom of Table 1 which encapsulate the present status.

Table 1. Black Hills Test Site 226A ERTS Images Received Since August 19, 1972 to Present.

NO.	IMAGE DATE	I.D. NUMBER	PERCENT COVERAGE	TEST SITE AREA		IMAGE QUALITY
				PERCENT CLOUD COVER	SNOW	
1	19 Aug 1972	1027-17065	10%	10%		Poor
2	6 Sep 1972	1045-17063	0%			Poor
3	6 Sep 1972	1045-17065	10%	40%		Fair
4	8 Sep 1972	1047-17175	15%			Fair
5	12 Oct 1972	1081-17064	0%			Fair
6	12 Oct 1972	1081-17070	0%			Fair
7	1 Nov 1972	1101-17183	20%			Fair
8	26 Sep 1972	1065-17175	20%	5%	X	Fair
9	31 Oct 1972	1100-17124	100%	0%	X	Good
10	31 Oct 1972	1100-17131	0%			Good
11	5 Dec 1972	1135-17072	5%	0%	X	Good
12	6 Dec 1972	1136-17132	0%			Good
13	6 Dec 1972	1136-17130	100%	0%	X	Excell
14	11 Jan 1973	1172-17130	5%	0%	X	Fair
15	11 Jan 1973	1172-17123	100%	0%	X	Good
16	12 Jan 1973	1173-17182	60%	0%	X	Good
17	29 Jan 1973	1190-17125	100%	0%	X	Good
18	28 Jan 1973	1189-17070	0%			Fair
19	28 Jan 1973	1189-17072	0%			Fair
20	10 Jan 1973	1171-17072	0%			Excell
21	10 Jan 1973	1171-17065	0%			Excell
22	29 Jan 1973	1190-17131	15%	0%	X	Fair
23	30 Jan 1973	1191-17184	15%	0%		
24	10 Jan 1973	1171-17065	5%	0%	X	Good
25	16 Feb 1973	1208-17133	10%	0%	X	Excell

Table 1. (Continued)

NO.	IMAGE DATE	I.D. NUMBER	PERCENT COVERAGE	TEST SITE AREA		IMAGE QUALITY
				PERCENT CLOUD COVER	SNOW	
26	16 Feb 1973	1208-17131	100%	0%	X	Excell
27	20 Aug 1972	1028-17121	100%	35%		Poor
28	15 Feb 1973	1207-17075	0%			Good
29	6 Mar 1973	1226-17131	30%	40%	X	Good
30	7 Mar 1973	1227-17190	0%			Good
31	25 Mar 1973	1245-17190	0%			Poor
32	11 Apr 1973	1262-17132	100%		X	Fair
33	11 Apr 1973	1262-17134	0%			Fair
34	12 Apr 1973	1263-17190	0%			Fair
35	28 Apr 1973	1279-17073	0%			Fair
36	28 Apr 1973	1279-17075	15%	80%	X	Fair
37	10 Apr 1973	1261-17073	0%			Fair
38	10 Apr 1973	1261-17080	0%			Fair
39	16 May 1973	1297-17072	0%			Fair
40	16 May 1973	1297-17074	0%			Fair
41	17 May 1973	1298-17130	65%	30%		Fair
42	18 May 1973	1299-17175	0%			Fair

- A. Number of images providing 100% coverage of the study site: 6
 1) Number of those images with less than 30% cloud cover: 5
 2) Number of those images without snow over entire study site: 0

- B. Number of images providing greater than 50% coverage of study site: 1
 1) Number of those images with less than 30% cloud cover: 0

2. In an attempt to relate other kinds of forest stress which might be detectable from ERTS, the principal investigator requested from Mr. Edward Crump in March 1973 data products from two new locations where known stress problems are occurring. One location is in the Berkeley hills near San Francisco where two million eucalyptus trees died from a

severe freeze in December 1972. The foliage of the affected trees turned yellow in February, and the trees retained most of their foliage until June. However, the native grassland vegetation dries out in late April and May and assumes the same color as the dead eucalyptus foliage. Thus, there is a period from February 15 to May 1 when discrimination should be possible, i.e., after the foliage changed color in February and before the grasses turned yellow in May.

Below is a listing of the three images we received:

<u>Date</u>	<u>Identification Number</u>
1/4/73	1165 - 13175
1/22/73	1183 - 18175
4/22/73	1273 - 18183
5/10/73	1291 - 18182

No ERTS frames were received in the period between January 22 and April 22, 1973, when maximum discrimination is possible.

On the large island of Hawaii, ohia, one of the native trees, is dying over a large area between the dormant volcanoes, Mauna Loa and Mauna Kea. Determination of the area affected is of great interest to the conservationists and to the island timber industry.

Two frames of the large island of Hawaii were received as follows:

<u>Date</u>	<u>Identification Number</u>
1/6/73	1167 - 20174
2/11/73	1203 - 20180

We were notified in April 1973 that the tape recorder on board ERTS failed, so no additional frames of this site will be available. This will make a trend estimate of ohia decline difficult. However, work is under way to relate the damage on the February image.

REVISION OF SENSORS FOR DCP's:

1. All five spectrometers were rebuilt and calibrated so that they would operate from portable power supplies (battery). On three of the spectrometers two additional channels were added (1.55 - 1.75 μ m and 10.2 - 12.5 μ m) to match not only ERTS-1 channels but also some of the EREP wavebands on the S-192 sensor. The DCP's were put into operation at our Atlanta site on June 3 to coincide with an expected SL-2 overflight. They have been operating continuously during daylight hours since June 3 until they were shut off on July 10. By having the sensors portable we can move them easily from inventory site to stress

site.

WORK PLANNED FOR NEXT REPORTING PERIOD:

1. Install three DCP's and ~~five~~ spectrometers on Black Hills test site to coincide with EREP passes in early August, with ERAP flights, and with Forest Service aircraft flights. These data will be used with ERTS imagery if we are fortunate to get clear weather during August at the time of ERTS overpasses.

2. The eucalyptus and ohia ERTS images will be combined, photographed and analyzed during this period.

3. Microdensitometer traces will be run on aircraft imagery and compared with traces of the September 8 color composite just received of ID number 1047-17175. Only a portion of the stress site is available on the ERTS image, however.

SIGNIFICANT RESULTS: None

PUBLICATIONS: None

RECOMMENDATIONS FOR CHANGES: Speed up ERTS data products requested.

STANDING ORDER FORM CHANGES: None

ERTS IMAGE DESCRIPTOR FORMS: 28 sent since January 1, 1973.

DATA REQUEST FORM CHANGES: None

TITLE: Inventory of Forest and Rangeland and Detection of Forest Stress

ERTS Proposal Number 226

Atlanta Test Site (Forest Inventory) 226B

Coinvestigator: Robert C. Aldrich

GSFC Identification Number AG-014

Principal Investigator: Robert C. Heller

STATEMENT OF PROBLEMS:

1. Long delays in receiving 70 mm bulk coverage for the Atlanta test site plus the additional delay for retrospective orders (three months) have frustrated our attempts to make a planned data analysis.

2. In the first nine months of operation the Atlanta site was wholly or partially covered by 65 ERTS scenes on 14 different dates. Of these, only 22 scenes had less than 20 percent cloud cover--17 had less than 10 percent. On only two 18-day pass periods was there complete coverage for the site--October 15-16, 1972, and April 13-14, 1973. This will make seasonal comparisons difficult.

3. Difficulties in obtaining bulk color composites that are properly exposed with good density and good color saturation have forced us to try producing our own. Since this was not part of our proposal it has caused some problems because of the additional work load.

4. Geometric errors in both precision color and bulk color composites have been found too great to continue with the data analysis plan as originally stated. A revised data analysis plan was submitted to Mr. S. Provenzano, Contracting Officer, on June 19.

5. We have had no aircraft support since October 2, 1972. A mission planned for April 1-15, 1973, was cancelled. This mission and a mission for June 1-15 were requested so that they would serve both ERTS and Skylab experimental needs. This dual-purpose coordination was requested by NASA. However, the April RB-57 support flight was cancelled by NASA/Houston for economy reasons, and the June flight was not flown because of poor weather conditions during Skylab overpasses on June 4 and June 9, 1973.

ACCOMPLISHMENTS DURING THE REPORTING PERIOD:

Preparations and Equipment Developments:

1. To monitor forest inventory and land use classification plots located on 1:120,000 scale high-altitude photography with ERTS 1:100,000 scale color composites, it was necessary to modify a Bausch and Lomb Zoom Transfer Scope (ZTS). The modification is a vertical slide adjustment for the plexiglas film platen. The platen now slides between aluminum channels on opposite edges of the illuminator. This allows the operator to change the vertical position of an ERTS film transparency without physically removing it from the illuminator. Another improvement that allows us to use 1:120,000 film transparencies on the map base of the ZTS is a table top with a built-in 70- x 10-inch illuminator. And finally, a foot switch was installed that allows the ZTS operator to independently blink the photo illuminator. By blinking the illuminator, images on the ERTS scene can be brought into close registration with corresponding images on 1:120,000 aerial photo transparencies. This makes it possible to detect changes or disturbances that have occurred in the forest at point locations.

2. A technique for calibrating an I²S viewer copying system was completed. The system includes a precisely constructed 9- x 9-inch duplicate of the ERTS (1:1,000,000 scale) registration points printed on stable base photographic film. The distances between registration points ("cross track" and "in track" distances) were measured on 70 mm bulk film for scene 1084-15440 using a three-micrometer accuracy comparator. Sixteen measurements were made in each direction, and the means of these measurements were used to plot the distances between registration marks to the nearest 0.01 mm on stable base material. The registration marks were plotted using a coordinatograph. This point plot was in turn contact printed on photographic film to make a negative. A contact transparency printed from the negative was attached to the I²S viewer screen, and a four-time positive reduction was attached to the focusing back of a Crown Graphic Camera. By adjusting the camera position, the four registration marks on the camera back were made to agree with the four marks on the viewer screen. Four MSS bulk 70 mm film bands could then be brought into proper registration at a 1:1,000,000 scale and copied.

3. 1:1,000,000 scale transparent overlays were made with both geographic plane coordinate intersections and UTM coordinate intersections. They were prepared using conventional cartographic and photographic techniques and include:

a. A grid of 10,000-meter UTM coordinate intersections for the test site.

b. A grid of 15-minute geographic coordinate intersections for the test site.

c. Fifteen four-mile square study areas including landmarks such as the Chattahoochee River, significant lakes, and centers of towns.

d. An outline map including five counties to be used in the new data analysis plan.

Aircraft and Ground Support:

1. There were no aircraft support or ground support missions during the six-month reporting period.

Film Data Analysis:

1. Bulk 70 mm multiband images for thirteen different ERTS scenes were combined on an I²S additive color viewer and photographed using Ektachrome (tungsten type) film. The procedures followed were outlined in Type I Progress Report - Number 3, dated March 8, 1973. A comparison between the quality of Goddard bulk color composites and I²S combined 70 mm bulk products shows that despite serious variations in color saturation and density, the Goddard composites are of superior resolution.

2. As a result of a close examination of the combined color products for 13 ERTS scenes, we decided to concentrate our future data analysis efforts on the eight best scenes that we have received to date. These scenes by season of coverage are listed below:

Season	Date	ERTS Scene	% Cloud Cover	% Area Covered
Fall	10/15/72	1084-15440	0	70
	10/16/72	1085-15494	30	20
	11/ 2/72	1102-15442	20	30
Winter	1/13/73	1174-15440	30	30
	1/14/73	1175-15495	0	60
	2/17/73	1209-15385	0	5
Spring	4/13/73	1264-15445	0	60
	4/14/73	1265-15503	0	50

3. There has been a lag of more than three months in the completion of retrospective orders for bulk color composites. Because of this lag, we have confined our data analysis efforts during the reporting period to an evaluation of geometric qualities of the imagery. For this evaluation we have used both bulk and precision data for ERTS scene 1084-15440.

The first test was made to check the location of geographic coordinate tick marks on the ERTS imagery and to check the I²S viewer calibration system. Overlays scaled to 1:1,000,000 were made with 15-minute plane coordinate intersections and 50,000-meter UTM intersections and include such features as the Chattahoochee River, major lakes, and centers of several small towns. These overlays were matched with the scenes imaged on the I²S viewer and on 9.5- x 9.5-inch bulk and precision imagery. In general, the results show that our I²S calibration and scaling techniques were quite accurate. However, we found that when geographic details in our overlays were made to coincide with the same details on the ERTS imagery, there was a considerable discrepancy in the geographic latitude tick marks on the ERTS scene. Thirty-minute latitude tick marks were four minutes south of their correct position. The 30-minute longitude tick marks appeared to be correct.

When the overlays were superimposed on precision (scene-corrected) film transparencies (band 5), we found that geographic coordinates and the 50,000-meter UTM tick marks were in close agreement.

Unless geographic plane coordinate intersections are more accurately placed on bulk data, ERTS users should rely on matching well-defined and recognizable control points in the ERTS scene with map locations scaled from 1:24,000 to 1:250,000 topographic map sheets.

4. A second test of the geometric fidelity of both precision and bulk 9.5- x 9.5-inch data products was conducted using 90 random control points. These points were located within a rectangle formed by thirty-minute geographic plane coordinate intersections--longitude 84°00'W, 84°30'W, and latitude 33°00'N, 33°30'N. The points were transferred from 1:120,000 scale color infrared (CIR) transparencies (dated October 2, 1972) to a 1:250,000 topographic map sheet using a Zoom Transfer Scope. An overlay of the point locations made on stable base material was copied photographically to a 1:1,000,000 scale. From this a transparent film template was printed to attach to the ERTS 1:1,000,000 scale image. This template included 15-minute plane coordinate intersections, 50,000-meter UTM grid intersections, and major features. The template was matched with both the precision image 1084-15440-5 and bulk composite 1102-15442-4, 5, and 7. Each ERTS image, with template attached, was mounted on the ZTS illuminator. Then the 1:120,000 scale CIR photo transparencies were oriented with the respective ERTS image on the ZTS mapping surface. The

distance between the actual image locations scribed on the photographs and the location of points on the ERTS images were measured. The results showed that a large part of the error was systematic. On precision data, the true ground position (photo) was always north of the ERTS location (mean 300 meters). On bulk color composites the true ground (photo) position was always east of the ERTS location (mean 520 meters).

5. Because it appears to be impossible to relocate the 800 land use cells (100 meters square) close enough to carry out the human interpretation test described in our proposal, we have requested a change in our data analysis plan. The plan as revised includes the interpretation and monitoring of some 200 to 400 permanent forest survey plot locations in five counties of north-central Georgia. The objective is to test the hypothesis that forest survey ground plot locations can be located on microscale imagery and that land use changes and forest disturbances caused by harvesting, land clearing, and natural catastrophes, on or near the plots, can be detected using optical comparators.

Digital Tape Analysis (Computer Processing):

1. The automatic interpretation of ERTS imagery is progressing very well. Our clustering methods which stratify the image elements indicate that forest can be separated from nonforest with a very high degree of accuracy. In addition, it is apparent that much separation between softwood and hardwoods can be done. The next analysis to be performed which is being prepared currently for input to the computer will give actual percentages of the area correctly typed.

2. The stratification procedures used lumped spectrally similar image elements into the same strata. The most successful method thus far in terms of producing strata related to forest types was done as follows: A frequency histogram for each channel was constructed and the median radiance value found. Image elements were then placed in one of sixteen categories below or equal to the median versus those above the median for each channel. This procedure resulted in little breakdown within nonforest lands and a number of strata within forested areas. Other methods tried included subtracting pixel means from the pixel data to have in effect a brightness correction. This did not seem to result in meaningful strata.

3. Other advances made during this period include the use of a color mapping system using an EAI 430 data plotter. Now land use and forest classification maps can be made to any scale and in any set of colors available in eight pens. Each plotted pass can use eight separate colors and any number of passes can be made. Prior to the use of the data plotter, we color-coded characters printed on a line printer by hand.

Besides the tediousness of this procedure, a major disadvantage was that some distortion was inevitable due to the nonvariable print grid.

4. Another aid used in comparing the ERTS digital imagery with the "ground truth" photos is a computer program that stretches the geometry of the data in linear ways. If the shape of a data block is skewed relative to the same block on the photo, this program stretches or shrinks the data in the appropriate directions.

5. Work is progressing on other clustering procedures and on procedures aimed at stratifying the data into ground types as opposed to spectral types.

WORK PLANNED FOR NEXT REPORTING PERIOD:

Preparations and Equipment Developments:

1. We will investigate and develop photographic techniques for combining, enhancing, enlarging, and reproducing ERTS photographic data.

a. Internegatives will be made of combined 9.5- x 9.5-inch bulk color composites. Using the internegatives contact color transparencies will be made to correct for and standardize film density and color.

b. Portions of internegatives made from Goddard bulk color composites will be enlarged to 1:500,000, 1:250,000, and 1:120,000 to illustrate land and forest classifications by seasons of the year.

c. Both internegative and Ektacolor negative film will be used in 8- x 10-inch film holders to produce 1:1,000,000 scale combined images at the focal plane of the I²S additive color viewer.

Aircraft and Ground Support:

1. A two-man team will visit 100 ground sample points in September and November to coincide with aircraft support missions planned for coordinated ERTS-Skylab coverage.

Film Data Analysis (Photo Interpretation):

1. Following acceptance of the change in our Data Analysis Plan, Forest Survey plots for five counties in the North Central Forest Survey Unit will be transferred from 1:20,000 scale (1961) panchromatic photographs to 1:120,000 scale color infrared (June 1972) and 7 1/2-minute

quadrangle map sheets. Each plot will be classified at the time of transfer into one or more of several land classifications. The UTM grid coordinates will be read for each point and converted to plane coordinates by computer techniques.

Each plot will be examined simultaneously on the 1:120,000 CIR film and sequential ERTS coverage to determine whether changes have occurred. Where changes are detected, they will be checked on new photography and on the ground.

2. Photographic keys will be developed to illustrate land use and forest classifications by season. These keys will include ERTS enlargements, high-altitude and low-altitude aircraft imagery, and ground photographs.

Digital Tape Analysis (Computer Processing):

1. Work will continue on several different clustering procedures and on procedures aimed at stratifying the data into ground types as opposed to spectral types.

2. A computer map will be produced for one 6.4-kilometer square (4-mile square) test area for which we have intensive ground truth data. This map will stratify the four channels of MSS data into forest types and land use classes using the best combination of clustering and supervised classification procedures that we have been able to modify or develop. Percentages of the area in each class will be computed and compared with ground truth.

3. MSS spectral signatures and classification procedures that have been developed will be extended to a second 6.4-kilometer square site eight miles northeast of the original site. A computer map will be produced that stratifies the four-channel MSS data into forest and nonforest classes. Percentages of the area by classes will be computed and compared with ground truth.

SIGNIFICANT RESULTS:

1. Kudzu vine (Pyeraria lobata), a serious threat to good land management in the Southeastern United States, can be detected on ERTS multispectral data. This perennial vine was introduced to the United States over 30 years ago as a forage plant. Since then it has become uncontrolled in some areas because of its rapid growth and its resistance to all manual control efforts. In many areas it has intruded on the forests and caused considerable tree mortality.

Kudzu has certain growth characteristics which make it detectable by ERTS. It begins growth in early June at the time local field crops begin their growth. From this point until early October, the vine is not detectable because its response to infrared is similar to leafy cash crops. However, in early October, Kudzu remains a thriving green blanket of IR reflectant foliage while neighboring crops are either mature, harvested, or they are dead and noninfrared reflectant. Thus, from early October to late October, Kudzu is a bright red even-textured target and can be detected on ERTS combined MSS bands 4, 5, and 7 displayed as simulated color infrared film. By mid-November, however, it becomes an even-textured gray blanket because its deciduous leaves have fallen to the ground. From this point until late spring, the winter cover crops become a bright red, and the gray-colored kudzu becomes difficult to separate from fields of dead perennial weeds and grasses.

PUBLICATIONS: None

RECOMMENDATIONS FOR CHANGES: None

STANDING ORDER FORM CHANGES: None

ERTS IMAGE DESCRIPTOR FORMS: 7 submitted

DATA REQUEST FORM CHANGES: None

TITLE: Inventory of Forest and Rangeland and Detection of Forest Stress

ERTS Proposal Number 226

Manitou Test Site (Rangeland Inventory) 226C

Coinvestigator: Richard S. Driscoll

GSFC Identification Number AG-014

Principal Investigator: Robert C. Heller

STATEMENT OF PROBLEMS:

1. The most significant problem encountered continues to be securing sufficiently cloud-free ERTS imagery of the 226C test site to proceed with our planned data analysis procedures. Of ten sets of ERTS data received, only one, Observation I.D. 1028-17135, includes a sufficient cloud-free area of the test site where we have significant ground truth that will be suitable for our analysis plans. Data products retrospectively ordered in February and March 1973 were finally all received by June 29, 1973. Due to the problem of lack of ERTS imagery of the Manitou area, we are now requesting, in addition, data of the Kremmling area, another location where we have significant amounts of ground truth.

2. Our microdensitometer (MDT) has required minor repair several times. This has delayed analysis of both ERTS imagery and supporting aircraft data by MDT. The machine appears to be fully operational now, so we should be able to proceed with that part of our analysis as planned.

3. We have had to reduce the number of data training and testing cells representing the different plant community systems we have established for supervised classification procedures. This was due to cloud cover in the selected ERTS imagery and cloud cover or no aerial photo coverage in the supporting aircraft imagery. This may reduce the sensitivity of our analysis; we are not yet certain.

ACCOMPLISHMENTS DURING THE REPORTING PERIOD:

1. Ten sets of MSS system-corrected image(SYCI) data have been received. These products were analyzed by visual interpretation to determine: (1) percent of test site imaged, (2) percent cloud cover of that portion of the test site included in the scene, and

(3) general quality of the imagery. These results are given below:

<u>Observation I.D.</u>	<u>Date</u>	<u>% of Test Site Included</u>	<u>% Cloud Cover of Test Site</u>	<u>General Quality</u>
1009-17075	8/1/72	15	20	Hazy but generally good
1027-17075	8/19/72	0	-	-
1028-17133	8/20/72	10	30	High cumulus, good
1028-17135	8/20/72	100 ¹	20	High cumulus, some cirrus, good
1028-17142	8/20/72	0	-	-
1065-17190	9/26/72	5	60	Large high cumulus, good
1279-17091	4/28/73	20	60	Hazy cirrus, thin, fair
1297-17090	5/16/73	25	15	High cumulus, dense, fair
1299-17200	5/18/73	100 ²	5	Dense, fair ³
1299-17203	5/18/73	5	0	Dense, Fair ³

¹ The Manitou Test Site, 226C

² The Kremmling Test-Site as a supportive alternate for the Manitou Site. Standing order form changes as of April 18, 1973.

³ The dense positive transparencies probably caused by sensor saturation due to a large amount of snow in the scene.

Visual interpretation of the color composite of I.D. No. 1028-17135 at a scale of 1:1,000,000 identifies the following:

- a. Water bodies as small as 80 meters wide can be identified provided the scene contrast is high; i.e. small lakes or beaver ponds surrounded by wet meadow type vegetation.
- b. The tree line, approximately 11,500 feet MSL within the Manitou Test Site, is readily discernible.
- c. Nonvegetated areas, including natural talus mountain slopes, exposed rock faces above timberline, and areas caused by mining activities, are discernible.

- d. Alpine tundra and grassland differentiate from lower elevation grasslands.
- e. Irrigated and fertilized high (9,000 to 10,000 feet MSL) mountain native hay meadows differentiate from nonculturally treated native hay meadows.
- f. Ponderosa pine forests appear to discriminate from other coniferous forest types due probably to less dense canopy cover.
- g. Spruce/fir, Douglas-fir, and lodgepole forest types are extremely difficult to differentiate by visual interpretation.
- h. Aspen forests differentiate from all other forest types.
- i. Scrub types differentiate from all other vegetation types but not among themselves. These include willow, mountain mahogany, and oakbrush plant communities.
- j. Dry mountain grasslands comprised primarily of tall bunchgrasses and associated forbs are identifiable from dry mountain grasslands where the herbaceous vegetation is approximately one-half as tall and 50 percent less dense.
- k. Road networks of developing urban developments are generally discernible in the grasslands but not in the forested areas. The tree canopy apparently shields part of these networks from view, and the spectral signatures of the networks are sufficiently integrated into the associated scene at this scale of imagery that they are not discrete.

We have not yet completed the point-sampling described in earlier reports by either visual or microdensitometric interpretation modes to establish probability statements. The sampling templates for the ERTS frame have been completed. The training and testing for plant community and land use classifications will proceed as quickly as possible.

The results listed above are based on examination of only one ERTS scene. We do not yet know what the shift in apparent image characteristics might be due to phenological changes in vegetation. We hope to determine the magnitude of these shifts, if they occur, and whether or not such changes aid in the visual or machine interpretation of the imagery.

Data for scene I.D. 1299-17200 were received June 29, 1973. Therefore, this material has not yet been interpreted.

2. Computer processing of the bulk CCT's of scene I.D. 1028-17135 is just beginning. To date, we have been successful in dropping out all clouds and cloud shadows imaged in approximately one-fourth of the test site. We had planned to use a supervised clustering procedure for the CCT processing. We may have to use an unsupervised clustering procedure due to the loss of plant community and land use class data points which occur under the imaged clouds or in cloud shadows or lack of positional accuracy in the data. These attributes will be precisely ascertained during the next reporting period.

3. All training and testing points representing the plant community and other land use classes have been transferred from USGS topographic maps to the multiscale color and color infrared photographs secured from RB-57 Missions 205 and 211. Descriptive photo interpretation keys have been developed for the 1:50,000 and 1:100,000 scale photographs and are nearly completed for the 1:400,000 scale photographs. Interpretation testing is just beginning.

4. Due to malfunctions of the microdensitometer previously mentioned, we had to remeasure the apparent optical density of ground cells imaged in three different film types to determine the relationships between measured radiance, standing crop biomass, and ground cover of four different grassland classes. These data are now ready for reprocessing and will be used to determine relationships between spectral density, spectral radiance, and ground conditions to quantify ERTS and ERAP imagery for selected plant community parameters.

5. We received on June 15, 1973, the 7-track CCT's of our ERAP C-130 Mission 213 data formatted in LARSYS-II. Analysis has not been initiated on these data.

WORK PLANNED FOR NEXT REPORTING PERIOD:

1. Make final determinations of the positional accuracy and radiometric fidelity of both SYCI and SCCI photographic products of scene I.D. 1028-17135 and scene I.D. 1299-17200. Revise data analysis plan if appropriate.

2. Complete descriptive photo interpretation key for the 1:400,000 ERAP photographs and the ERTS scene I.D. 1028-17135 and continue with visual and microdensitometric interpretation and analysis.

3. Complete analysis for spectral density, spectral radiance, and ground condition interrelations and apply the results to ERTS and ERAP imagery.

4. Subjectively select sections of scene I.D. 1028-17135 containing cloud-free data for pattern recognition processing of the bulk and/or CCT's

through either supervised or unsupervised clustering. The technique used will depend on whether or not we can accurately find the preselected training and testing data points in the CCT's.

5. Two men will spend approximately four days in the field to ascertain the phenology of selected plant community systems at the time of each planned ERTS pass during the 1973 growing season.

6. The coinvestigator will confer with the principal investigator and the other two coinvestigators to determine the full progress of the study and make detailed plans for completing the study. At the same time, the utility of image enhancement of selected and available ERTS imagery will be determined using the I²S system at Berkeley, California.

7. Initiate analysis of the 24-channel data secured from ERAP Mission 213.

SIGNIFICANT RESULTS:

The following significant results have been found through visual interpretation of the color composite of ERTS scene I.D. 1028-17135:

1. Land use activities resulting from mining by surface dredging and tunneling and new urban developments in relatively flat grassland areas can be identified using the 1:1,000,000 ERTS color composite. New urban developments in forested areas cannot be identified.

2. Six different grassland plant community classes are identifiable and include irrigated and fertilized native hay meadows, non-culturally treated native hay meadows, dense mountain bunchgrass communities, dry mountain grassland, alpine tundra, and alpine grasslands.

3. Three scrub communities--willow, mountain mahogany, and oak-brush--cannot yet be differentiated among themselves.

4. The tree line at approximately 11,500 feet MSL is readily discernible.

5. Water bodies, including small lakes and ponds approximately 80 meters wide, are readily identified provided they occur where the scene contrast is high as in meadow type vegetation.

6. Ponderosa pine (coniferous) and aspen (deciduous) forest types are the only two forest types that can be identified consistently.

Spruce/fir, Douglas fir, and lodgepole pine forests cannot be consistently separated by visual interpretation.

PUBLICATIONS: None

RECOMMENDATIONS FOR CHANGES: None at present

STANDING ORDER FORM CHANGES: None at present

ERTS IMAGE DESCRIPTOR FORMS: A total of 10 submitted

DATA REQUEST FORM CHANGES: Send a new pad of data request forms.

21

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. Type II-2		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle TYPE II PROGRESS REPORT: INVENTORY OF FOREST AND RANGELAND AND DETECTION OF FOREST STRESS				5. Report Date July 10, 1973	
				6. Performing Organization Code	
7. Author(s) Robert C. Heller, Robert C. Aldrich, Frederick P. Weber, Richard S. Driscoll				8. Performing Organization Report No. FS-II-2	
9. Performing Organization Name and Address Forest Service, U. S. Department of Agric. Pacific Southwest Forest & Range Exp. Station P. O. Box 245 Berkeley, California 94701				10. Work Unit No.	
				11. Contract or Grant No. 5-70251-AG	
12. Sponsoring Agency Name and Address Edward Crump, Technical Monitor Code 430, GSFC Greenbelt, Maryland 20771				13. Type of Report and Period Covered Type II-Progress Report Jan 1 -- June 30, 1973	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract Visual interpretation of our range site on the bulk color composite of scene 1028-17135 permits us to (1) identify six different grassland communities, (2) separate grasslands from scrub communities and forest land, (3) identify ponderosa pine from aspen but not to separate spruce-fir, Douglas-fir, and lodgepole pine from each other, (4) identify surface dredging and new urban developments in flat grasslands but not to identify new urban developments in forested areas, (5) determine that we cannot separate three scrub communities--willow, mountain mahogany, and oakbrush--from each other. Kudzu vine is a serious threat to forest management in Southeastern United States and can be detected on ERTS multispectral data from early October to mid-November. At other dates, earlier or later, it is confused with other crops. All three forest sites have suffered from excessive cloudiness on ERTS images, lack of coverage over the site, or snow coverage reducing contrast ratios below usable levels. One good image of the island of Hawaii was received and the dying of native ohia trees between Mauna Loa and Mauna Kea volcanoes shows up as a dark area on the combined 70 mm image. We look forward to receiving a good bulk color composite from GSFC.					
17. Key Words (Selected by Author(s)) Forest inventory, forest stress, rangeland inventory, photogrammetry, automatic data processing and signature analysis				18. Distribution Statement	
19. Security Classif. (of this report) None		20. Security Classif. (of this page) None		21. No. of Pages	
				22. Price*	

*For sale by the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151.

Figure 2. Technical Report Standard Title Page